



**Iowa Department  
of Transportation**

**ANNUAL REPORT  
of  
Iowa Highway Research Board  
Research and Development Activities  
FY 2012**

**Attachment to  
FY 2012 Annual Report  
Research, Intelligent Transportation Systems, and  
Technology Transfer Activities**



**DECEMBER 2012**

**ANNUAL REPORT  
OF  
IOWA HIGHWAY RESEARCH BOARD  
RESEARCH AND DEVELOPMENT ACTIVITIES**

**FOR THE  
FISCAL YEAR ENDING JUNE 30, 2012**

OFFICE OF RESEARCH AND ANALYTICS  
OPERATIONS RESEARCH  
(515) 239-1447

**[www.iowadot.gov/operationsresearch](http://www.iowadot.gov/operationsresearch)**

PERFORMANCE AND TECHNOLOGY DIVISION  
IOWA DEPARTMENT OF TRANSPORTATION  
AMES, IOWA 50010

**DECEMBER 2012**

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## LIST OF ACRONYMS

AASHTO - American Association of State Highway and  
APWA - American Public Works Association  
ASCE - American Society of Civil Engineers  
DOT - Department of Transportation  
FHWA - Federal Highway Administration  
GIS - Geographic Information System  
HMA - Hot Mix Asphalt  
HPC - High Performance Concrete  
IHRB - Iowa Highway Research Board  
ISU - Iowa State University  
LiDAR - Light Detection and Ranging  
LRFD - Load and Resistance Factor Design  
LTAP - Local Technical Assistance Program  
LVR - Low Volume Road  
MOVITE - Missouri Valley Section of the Institute of Transportation Engineers  
NCHRP - National Cooperative Highway Research Program  
SUDAS - Statewide Urban Designs and Specifications  
TAC - Technical Advisory Committee  
TRB - Transportation Research Board  
UHPC - Ultra High Performance Concrete  
USGS - United States Geological Survey  
WMA - Warm Mix Asphalt

## RESEARCH AND DEVELOPMENT

The Iowa DOT engages in research and development for two reasons: first, to find workable solutions to the many problems that require more than ordinary, routine investigation; and second, to identify and implement improved engineering and management practices.

This report, entitled “Iowa Highway Research Board Research and Development Activities FY2012” is submitted in compliance with Sections 310.36 and 312.3A, Code of Iowa, which direct the submission of a report of the Secondary Road Research Fund and the Street Research Fund, respectively. It is a report of the status of research and development projects in progress on June 30, 2012. It is also a report on projects completed during the fiscal year beginning July 1, 2011 and ending June 30, 2012. Detailed information on each of the research and development projects mentioned in this report is available from the Office of Research and Analytics, Performance and Technology Division, Iowa Department of Transportation. All approved reports are also online for viewing at: [www.iowadot.gov/operationsresearch/reports.aspx](http://www.iowadot.gov/operationsresearch/reports.aspx).

## THE IOWA HIGHWAY RESEARCH BOARD

In developing a progressive, continuing and coordinated program of research and development, the Iowa DOT is assisted by the IHRB. This advisory group was established in 1949 by the Iowa State Highway Commission to respond to the research denoted in Sections 310.36 and 312.3A of the Code of Iowa.

The Research Board consists of 15 regular members: seven Iowa county engineers, four Iowa DOT engineers, one representative from Iowa State University, one from The University of Iowa, and two engineers employed by Iowa municipalities. Each regular member may have an alternate who will serve at the request of the regular member. The regular members and their alternates are appointed for a three year term. The membership of the Research Board as of June 30, 2012, is listed in Table I.

The Research Board held eight regular meetings during the period from July 1, 2011, through June 30, 2012. Suggestions for research and development were reviewed at these meetings and recommendations were made by the Board.



Members of the IHRB are serious about the future of transportation. Understanding that every research project has the potential to strengthen the infrastructure, save lives, time and precious resources, they work hard to make sure new methods, technologies and materials are developed efficiently and economically for application in the real world. **The IHRB has received national attention as a leader in transportation research implementation.**

## 2012 IOWA HIGHWAY RESEARCH BOARD

<u>Member</u>	<u>Term Expires</u>	<u>Alternate</u>
Ahmad Abu-Hawash, Vice Chair Chief Structural Engineer Iowa DOT - Bridges and Structures 800 Lincoln Way Ames, IA 50010 (515) 239-1393 Email: <a href="mailto:ahmad.abu-hawash@dot.iowa.gov">ahmad.abu-hawash@dot.iowa.gov</a>	12-31-12	Deanna Maifield Methods Engineer Iowa DOT – Office of Design 800 Lincoln Way Ames, IA 50010 (515) 239-1402 Email: <a href="mailto:Deanna.Maifield@dot.iowa.gov">Deanna.Maifield@dot.iowa.gov</a>
James Berger Director of Materials Iowa DOT 800 Lincoln Way Ames, IA 50010 (515) 239-1843 Email: <a href="mailto:james.berger@dot.iowa.gov">james.berger@dot.iowa.gov</a>	12-31-12	Kevin Jones Materials Testing Engineer Iowa DOT 800 Lincoln Way Ames, IA 50010 (515) 239-1237 Email: <a href="mailto:Kevin.Jones@dot.iowa.gov">Kevin.Jones@dot.iowa.gov</a>
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## **RESEARCH AND DEVELOPMENT PROJECTS**

Proposals for research and development are reviewed by the Iowa Highway Research Board. The Board's recommendations are transmitted to the director of the Performance and Technology Division of the Iowa Department of Transportation. Expenditure of research and development funds is then authorized on an individual project basis.

These expenditures may be charged to the Primary Road Research Fund, Secondary Road Research Fund or the Street Research Fund, depending on which road system will benefit from the project. If more than one jurisdiction's roads share in benefits, the costs are shared.

Table II is a record of expenditures for research and development made during the fiscal year ending June 30, 2012. Total expenditure was \$2,088,802.08.

## **IN-HOUSE RESEARCH AND DEVELOPMENT**

Research and development projects performed by Iowa DOT personnel are termed "in-house" projects. These projects may involve other departmental and field personnel in addition to personnel from The Office of Research and Analytics, Operations Research Section. In many instances, personnel from other offices are designated as a project principal investigator, which means that they have a major role in the planning, performance and analysis of the research.

Contract research funds may be used for material and equipment costs for in-house research, but cannot be used for salary or personal expenses of the participating personnel. Consequently, the contract amounts for in-house projects are relatively small. The Office of Research and Analytics, Operations Research Section, wishes to express its appreciation to other offices for their assistance.

## **NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM**

The NCHRP was organized by the American Association of State Highway Officials (now the American Association of State Highway and Transportation Officials—AASHTO). The program is administered by the TRB, a branch of the National Academy of Sciences.

The purpose of NCHRP is to provide the funds and direction for research in highway matters of national concern. The program is funded annually by all fifty states in an amount equal to 5.5% of the federal aid allocated to the states for statewide planning and research (SPR). Iowa's obligation and actual expenditure for NCHRP varies and may be influenced by billing practices.

## SECONDARY ROAD TRAFFIC COUNT PROGRAM

Secondary road traffic counts are conducted annually and funded from the Secondary Road Research Fund as Non Contract Engineering Studies. The Office of Transportation Data conducted traffic counts in 25 counties during fiscal year 2012 as part of the Annual Traffic Count Program. This activity consisted of 5400 portable recorder classification counts and 100 portable recorder volume counts. Traffic volumes from these counts are used to develop Motor Vehicle Traffic Flow Maps for each county showing the Annual Average Daily Traffic (AADT) on specific road sections within each county.

Secondary roads geometrics and current condition inventories were requested from all 99 counties and 92 of those submitted information. This data provides county engineers, highway engineers, planners and administrators with essential information needed to determine design standards, to systematically classify highways, and to develop programs for improvement in maintenance of secondary roads.

## SECONDARY ROAD RESEARCH FUND

Section 310.34 of the Iowa Code authorizes the Iowa Department of Transportation to set aside each year an amount not to exceed 1½% of the receipts to the Farm-to-Market Fund in a fund to be known as the Secondary Road Research Fund. This authorization was first made in 1949; it was repealed in 1963, and reinstated in 1965. When the fund was reinstated, the fund was designated to finance engineering studies and research projects. The Iowa Department of Transportation accounting procedure for the Secondary Road Research Fund is based on obligations for expenditures on research projects and not the actual expenditures.

The fiscal year 2012 financial summary is:

Beginning Balance 7-1-11		\$ 850,482.76
Receipts		
State Road Use Tax Fund		
(1½% of receipts)	\$1,270,172.68	
Federal Aid Secondary		
(1½% of receipts)	0.00	
Research Income	<u>0.00</u>	
Sub-Total		<u>\$1,270,172.68</u>
Total Funds Available		\$2,120,655.45
Obligation for Expenditures		
Obligated for		
Contract Research	\$1,206,236.54	
Non-Contract		
Engineering Studies	<u>\$57,316.46</u>	
Total Expenditures		<u>\$1,263,553.00</u>
Ending Balance 6-30-12		\$857,102.45



## STREET RESEARCH FUND

The Street Research Fund was established in 1989 under Section 312.3A of the Iowa Code. Each year \$200,000 is set aside from the street construction fund for the sole purpose of financing engineering studies and research projects. The objective of these projects is more efficient use of funds and materials available for construction and maintenance of city streets. The Iowa Department of Transportation accounting procedure for the Street Research Fund is based on obligations for expenditures on research projects and not the actual expenditures. The fiscal year 2011 financial summary is:

Beginning Balance (7-1-11)	\$220,316.86
De-obligated (Unused) Funds from Previous Projects	\$7,446.17
FY11 Street Research Funding	<u>\$200,000.00</u>
Total Funds Available for Street Research	\$427,763.03
Total Obligated for Expenditure FY12	<u>\$208,716.00</u>
Ending Unobligated Balance 6-30-12	\$219,047.03

## PRIMARY ROAD RESEARCH FUND

The Primary Road Research Fund is sourced from non-obligated funds of the Primary Road Fund. These funds can only be expended on Iowa DOT projects for which the funds were reserved, such as contracted research and project-specific research supplies or equipment. An estimate of Primary Road Research Fund expenditures is made prior to the beginning of each fiscal year. The amount expended for contract research from the Primary Road Research Fund for FY12 was \$667,751.18 and the estimate for FY13 is \$750,000.

## PROJECTS INITIATED DURING FY 2012

- HR-140 (140H) Collection and Analysis of Streamflow Data
- HR-296 Iowa State University Local Technical Assistance Program (LTAP)
- TR-636 Optimization of Snow Drifting Mitigation & Control Methods for Iowa Conditions
- TR-637 Risk Mitigation Strategies for Operations and Maintenance Activities
- TR-638 Alkali Content in Fly Ash Measuring & Testing Strategies for Evaluating Compliance
- TR-639 Revision to the SUDAS Traffic signal Standards Phase II
- TR-640 Evaluation and Guidance on Effective Traffic Calming for Small Communities
- TR-641 Automation of DEM Cutting for Hydrologic/Hydraulic Modeling
- TR-642 Low Cost Rural Road Surface Alternatives
- TR-643 Investigation into Shrinkage of High Performance Concrete Used for Iowa Bridge Decks and Overlays
- TR-644 Pilot Construction for Granular Shoulder Stabilization
- TR-645 Warm Mix Asphalt Phase II: Evaluation of WMA Quality Assurance Testing Protocols
- TR-646 Development of Bridge Inspection, Load Rating & Maintenance Manuals
- TR-647 Methods for Removing Concrete Decks from Bridge Girders
- TR-648 Evaluation and Testing of a Light-Weight Fine Aggregate Concrete Bridge Deck in Buchanan County, Iowa

**15 Projects Initiated**

## PROJECTS COMPLETED DURING FY 2012

The following projects were completed during FY 2012 and project Final Reports were approved by the Iowa Highway Research Board:

- TR-568 Modified Sheet Pile Abutments for Low Volume Bridges
- TR-573 Development of LRFD Design Procedures for Bridge Piles in Iowa
- TR-575 Embedded (MEMS) Micro-Electromechanical Sensors & Systems for Monitoring Highway Structures & for Infrastructure Management
- TR-583 Field Testing of Piles & Development of a Wave Equation Method for Pile Design in IA
- TR-584 Establishing a Dynamic Formula for Pile Design & Construction Control of Pile Driving
- TR-597 Wet Reflective Pavement Marking Demonstration Project
- TR-601 Roadway Lighting and Safety: Phase II (TR-540) Monitoring, Quality, Durability and Efficiency
- TR-604 Field Testing and Evaluation of a Demonstration Timber Bridge
- TR-605 Evaluation of the Buena Vista IBRD Bridge: A Furthering of Accelerated Bridge Construction in Iowa
- TR-606 Iowa Public Employees Leadership Academy (LTAP)
- TR-609 Curing Criteria for Cold In-Place Recycling Phase III
- TR-618 Parallel Wing Headwalls for Single RCBs (LRFD)
- TR-620 Update of RCB Culvert Standards to LRFD Specifications
- TR-621 Geosynthetic Reinforced Soil for Low Volume Bridge Abutments
- TR-627 Risk Mitigation Strategies for Operations and Maintenance Activities

**15 Projects Completed and Approved**

**Table II**  
**FINANCIAL SUMMARY OF RESEARCH AND DEVELOPMENT PROJECT EXPENDITURES**  
July 1, 2011 to June 30, 2012  
*(Active projects with no current fiscal year expenditures are not included)*

Project #	Project Title	Primary Road Research Fund Expenditures	Secondary Road Research Fund Expenditures	Street Research Fund Expenditures	Total Expenditures
HR375	Transportation Research Board Education for County Engineers		1,777.64		1,777.64
HR140	Collection & Analysis of Streamflow Data	62,412.50	95,460.00	23,865.00	181,737.50
HR296	ISU Local Technical Assistance Program (LTAP)	54,006.70	95,351.14	18,773.04	168,130.88
HR1027	Secondary Road Research Coordinator (Annual Funds)		57,316.46		57,316.46
TR519	Developing Flood-Frequency Discharge Estimation Methods for Small Drainage Basins in Iowa			12,720.00	12,720.00
TR573	Development of LRFD Design Procedures for Bridge Piles in Iowa	33,036.15			33,036.15
TR575	Embedded (MEMS) Micro-Electromechanical Sensors & Systems for Monitoring Highway Structures & for Infrastructure Management	6,079.51	2,236.23	1,519.56	9,835.30
TR579	Low Cost Strategies to Reduce Speed and Crashes on Curves	1,100.31	849.72	96.72	2,046.75
TR583	Field Testing of Piles & Development of a Wave Equation Method for Pile Design in IA	156.09			156.09
TR597	Wet Reflective Pavement Marking Demonstration Project	3,169.53			3,169.53
TR598	Development of Updated Specifications for Roadway Rehabilitation Techniques	5,991.90	55.37	146.15	6,193.42
TR601	Roadway Lighting and Safety: Phase II (TR-540) Monitoring, Quality, Durability and Efficiency	14,326.08	8,226.70	931.54	23,484.32
TR604	Field Testing and Evaluation of a Demonstration Timber Bridge		12,315.39		12,315.39
TR605	Evaluation of the Buena Vista IBRD Bridge: A Furthering of Accelerated Bridge Construction in Iowa	27,285.08	1,621.98	166.85	29,073.91
TR606	Iowa Public Employees Leadership Academy (LTAP)		23,604.05	12,500.81	36,104.86
TR608	Assessment of Iowa County Roadway Financing Needs, Phases 1-4	9,919.15	23,742.52	5,362.17	39,023.84
TR609	Curing Criteria for Cold In-Place Recycling Phase III	26,346.65			26,346.65
TR613	Study of the Impacts of Implements of Husbandry on Iowa Bridges	36,624.97	5,990.99	8,509.88	51,125.84
TR614	Structural Characterization of a UHPC Waffle Bridge Deck and its Connections		1,553.02	474.60	2,027.62
TR615	Connection Details and Field Implementation of UHPC Piles - Phase II: Use of Ultra-High Performance Concrete in Geotechnical and Substructure Applications	37,827.84	57,896.64	4,444.18	100,168.66
TR616	Timber Abutment Piling and Back Wall Rehabilitation and Repair		96,108.39		96,108.39
TR617	An Adaptive Field Detection Method for Bridge Scour Monitoring Using Motion-Sensing Radio Transponders (RFIDs)		34,759.76	4,125.63	38,885.39
TR619	Development of Self-Cleaning Box Culvert Design - Phase II - additional funding for field test approved 6/25/10 \$9679	28,852.72	346.18	6,984.93	36,183.83
TR620	Update of RCB Culvert Standards to LRFD Specifications	81,073.14	10,593.58	3,761.31	95,428.03

Project #	Project Title	Primary Road Research Fund Expenditures	Secondary Road Research Fund Expenditures	Street Research Fund Expenditures	Total Expenditures
TR621	Geosynthetic Reinforced Soil for Low Volume Bridge Abutments	31,305.44	1,648.06	41.52	32,995.02
TR622	Maintenance and Design of Steel Abutment Piles in Iowa Bridges		22,113.56		22,113.56
TR623	Quality Control/Quality Assurance Testing for Joint Density and Segregation of Asphalt Mixtures	17,494.39	39,623.23	4,901.87	62,019.49
TR624	Development of Quality Standards for Inclusion of High Recycled Asphalt Pavement Content in Asphalt Mixtures	33,026.32	41,201.59	1,514.37	75,742.28
TR625	Improving Accuracy of Deflection & Camber Predictions for Prestressed Concrete Bridge Girders		49,000.48	25,000.00	74,000.48
TR626	Optimization of Snow Drifting Mitigation & Control Methods for Iowa Conditions	52,784.30	32,098.41	7,525.78	92,408.49
TR627	Risk Mitigation Strategies for Operations and Maintenance Activities	31,931.00	15,735.35	5,598.99	53,265.34
TR628	Alkali Content in Fly Ash Measuring & Testing Strategies for Evaluating Compliance		18,220.75	14,979.00	33,199.75
TR629	Revision to the SUDAS Traffic signal Standards Phase II	29,179.62	34,620.20	4,973.72	68,773.54
TR630	Evaluation and Guidance on Effective Traffic Calming for Small Communities	292.55	10,786.63	5,286.28	16,365.46
TR631	Automation of DEM Cutting for Hydrologic/Hydraulic Modeling	6,055.81	33,666.17	7,387.00	47,108.98
TR632	Low Cost Rural Road Surface Alternatives		27,659.43		27,659.43
TR633	Investigation into Shrinkage of High Performance Concrete Used for Iowa Bridge Decks and Overlays	5,293.33	41,937.46	12,500.00	59,730.79
TR634	Pilot Construction for Granular Shoulder Stabilization	20,519.82	42,960.00	8,592.00	72,071.82
TR635	Warm Mix Asphalt Phase II: Evaluation of WMA Quality Assurance Testing Protocols	11,660.28	44,744.77	16,288.25	72,693.30
TR636	Bridge Damage Detection: Integration of Structural Health Monitoring System Concepts and Components - A Statewide Collaboration		54,457.87	30,343.00	84,800.87
TR638	Western Iowa Missouri River Flooding – Geo-Infrastructure Damage Assessment, Repair and Mitigation Strategies		15,628.21	8,275.50	23,903.71
TR639	Development of Bio-Based Polymers for Use in Asphalt		39,693.12	14,996.00	54,689.12
TR640	Optimizing Pavement Base, Subbase, and Subgrade Layers for Cost and Performance on Local Roads		11,508.31		11,508.31
TR641	Reflective Crack Mitigation Guide for Flexible Pavements			9,877.45	9,877.45
TR643	Evaluating Roadway Subsurface Drainage Practices		12,017.76	11,997.00	24,014.76
TR646	Development of Bridge Inspection, Load Rating & Maintenance Manuals		7,463.68		7,463.68
Project Totals		667,751.18	1,126,590.80	294,460.10	2,088,802.08

## HR-140

**Agency:**

United States  
Geological Survey

**Principal Investigator:**

Rob Middlemis-  
Brown

**Research Period:**

July 1, 1967 to  
September 30, 2013  
Annual Renewal

**Research Board Funding:**

\$260,340

**Funding Source:**

45% Federal funds,  
55% State –  
40% Primary funds  
50% Secondary funds  
10% Street funds

## Collection and Analysis of Stream Flow Data

**Objective:** Collect the data necessary for analytical studies (including flood-frequency discharge estimation) and to define, for any location, the statistical properties and trends in discharge or elevation of streams, lakes, and reservoirs; Define the water-surface-elevation profiles and corresponding discharges along streams in basins with at least 100 mi<sup>2</sup> of drainage area for selected floods and evaluate the flood characteristics and hydraulics at existing and proposed flow structures in basins of all sizes when requested.

**Progress:** Data collection and annual reporting of stream flow data is ongoing annually.

**Reports:** Annual Report, Flood Event Reports

**Implementation:** Flood frequency and discharge data is used for sizing hydraulic structures in Iowa. Structure design agencies use this data for their designs.



U.S. Geological Survey measures the high water mark on the Cedar River at the Janesville stream gage on June 10, 2008. The record discharge for this site was set that day with streamflow measured at 53,400 cfs.

*Photo: U.S. Geological Survey*

## HR-296

**Agency:**

Iowa State University

**Principal Investigator:**

Keith Knapp

**Research Period:**

October 1, 1986 to  
December 31, 2012

**Research Board Funding:**

\$145,000

**Funding Source:**

Federal funds, 15.4%  
Safety funds, State  
Funds, Workshop  
income funds

State –

40% Primary funds

50% Secondary funds

10% Street funds

*promote research -  
encourage implementation -  
distribute research data*

## Iowa State University Local Technical Assistance Program (LTAP)

**Objective:** Assist Iowa's local governments with growing demands on local roads, streets, bridges, and public transportation. The center provides technical and managerial assistance to Iowa's local transportation officials through a variety of programs.

**Progress:**

- Publish *Technology News* newsletters
- Conduct training courses and workshops
- Distribute publications
- Provide service and information to users
- Present transportation safety information to rural communities by employing a Transportation Safety Circuit Rider

**Reports:** Newsletters, Annual Report

**Implementation:** Implementation of research findings and the proper training of state and county employees will improve the quality and reduce the cost of road construction and maintenance.



## HR-375

**Agency:**

Iowa Department of  
Transportation,  
Performance and  
Technology Division

**Principal  
Investigator:**

Mark Dunn

**Research Period:**

November 1, 1994 to  
on-going

**Research Board  
Funding:**

\$37,400

**Funding Source:**

100% State -  
100% Secondary  
funds

## Transportation Research Board Education for County Engineers

**Objective:** Annually send county engineers to the TRB Annual Meeting in Washington, D.C., for research education. County engineers selected are generally those starting their term as regular members of the IHRB. Attendance at the TRB Annual Meeting gives county engineers serving on the IHRB a better understanding of research at a national and international level. Additional benefits may be gained as the county engineers begin to develop ideas for research from their experience at the TRB meeting.

**Progress:** Between 1995-2012, 26 county engineers have received funding through IHRB to attend the Annual TRB meeting in Washington, D.C.

**Reports:** None

**Implementation:** County engineers who have attended the conference say it was a very good educational experience and that it educates and encourages them to better serve their counties and the IHRB.



Dr. Martin Wachs, Director, Transportation, Space and Technology Program, Rand Corporation, delivers the Thomas B. Deen Distinguished Lecture during TRBs 88<sup>th</sup> Annual meeting in Washington, D.C. on January 11, 2010.

*Photo: Cable Risdon, Transportation Research Board*



## TR-519

### Phase II

**Agency:**

United States  
Geological Survey  
(USGS)

**Principal Investigator:**

David Eash

**Research Period:**

June 1, 2004 to  
March 31, 2013

**Research Board Funding:**

\$464,777

**Funding Source:**

44.3% Federal funds  
and 55.7% State -  
45% Primary funds,  
45% Secondary funds  
and 10% Street funds

## Implementing a StreamStats Web Site for Iowa and Developing Flood-Estimation Equations for Small and Large Drainage Basins

**Objective:** Develop a comprehensive flood-estimation method for unregulated, rural streams in Iowa. Specifically:

- Implement an interactive StreamStats Web site for all of Iowa that allows users to easily select stream sites and estimate flood-frequency discharges by automating the measurement of basin characteristics and calculation of regression estimates
- Develop two sets of regional regression equations to estimate 2-, 5-, 10-, 25-, 50-, 100-, 200-, and 500-year flood-frequency discharges
- Develop the smallest drainage-area range for a transition zone as possible for Iowa to prevent the possibility of small-basin regression estimates exceeding large-basin regression estimates

**Progress:** The first draft of the final report was completed in early October 2012 and the report is receiving USGS peer review. Final review will be complete by mid-January 2013.

GIS data layers from the study were sent to the National StreamStats Team who will start implementing the data from the study after the report is approved. Publication of the report and implementation of StreamStats will be complete by the end of March 2013.

**Reports:** Draft Final Report

## TR-573

**Agency:**

Iowa State University

**Principal Investigator:**

Sri Sritharan

**Research Period:**

July 1, 2007 to  
March 31, 2012

**Research Board Funding:**

\$250,000

**Funding Source:**

100 % State -  
45 % Primary funds,  
55 % Secondary  
funds

## Development of LRFD Design Procedures for Bridge Piles in Iowa

**Objective:** Examine current pile design and construction procedures used by the Iowa DOT and recommend changes and improvements to those that are consistent with available pile load test data, soils information and bridge design practice recommended by LRFD. It is a priority to work towards recommended changes that do not significantly increase design and construction costs.

**Reports:** Final Report, June 2010

**Implementation:** This research will provide direct benefits to bridge infrastructure in Iowa, including the development and implementation of LRFD design procedures for bridge piles in Iowa to ensure the uniform reliability of bridges while providing cost-effective solutions to foundation designs in accordance with the LRFD specifications and local soil conditions.

A training course will be designed for engineers at the Iowa DOT, emphasizing the importance of collaboration between structural, geotechnical and construction engineers. Other participants from transportation agencies will also be attending.

## TR-579

**Agency:**

Iowa State University

**Principal****Investigator:**

Shauna Hallmark

**Research Period:**

November 1, 2007 –  
December 31, 2011

**Research Board  
Funding:**

\$80,000

**Funding Source:**

100 % State -  
40 % Primary funds,  
50 % Secondary  
funds and  
10 % Street funds

## Low Cost Strategies to Reduce Speed and Crashes on Curves

**Objective:** Evaluate the effectiveness of dynamic speed feedback signs and other low-cost strategies to reduce speeds and crashes on curves. Research results will provide traffic safety and county engineers and other professionals with additional tools to more effectively manage speeds and decrease crashes on horizontal curves on rural roadways.

**Reports:** Final Report, June 29, 2012

**Implementation:** Iowa counties will benefit from this research (among others) by obtaining another tool for improving safety on rural curves. A number of treatments have been used but their effectiveness is not known. Additionally, use of the project as matching funds to the FHWA project allows us to leverage federal funding to evaluate treatments in Iowa and to be able to compare those results to other sites nationally.



**Two strategies being  
evaluated in this research:**

A dynamic sign triggered by  
speeds above a safe threshold.



A static, painted  
warning sign.



## TR-583

**Agency:**

Iowa State University

**Principal Investigator:**

Sri Sritharan

**Research Period:**

January 1, 2008 –  
February 28, 2011

**Research Board Funding:**

\$380,000

**Funding Source:**

100 % State -  
40 % Primary funds,  
50 % Secondary  
funds and  
10 % Street funds

## Field Testing of Piles and Development of a Wave Equation Method for Pile Design in Iowa

**Objective:**

- Install and load test piles in the field
- Collect complete data including driving data
- Improve design of piles in accordance with LRFD specifications
- Develop a suitable dynamic analysis method for pile design
- Disseminate research outcomes to bridge designers in Iowa and elsewhere

**Reports:** Final Report, September 2011.

**Implementation:** The project team will organize and deliver a training course to supplement the Final Report and expedite implementation of project results into actual design and field practice. Designed for engineers in the office of Bridges and Structures, Soils Design Section, and the Construction Office at the Iowa DOT, the course will be delivered over a period of one to three days and clearly emphasize the importance of collaboration between structural, geotechnical, and construction engineers.

Other interested participants from county and city transportation agencies will also be invited. Depending on need, FHWA experts on LRFD may contribute to the course by providing an overall perspective on the implementation of project outcomes based on their experience with other bridge design agencies.

## TR-589

**Agency:**

National Weather Service

**Principal Investigator:**

National Weather Service

**Research Period:**

April 1, 2008 – September 30, 2012

**Research Board Funding:**

\$137,937

**Funding Source:**

100 % State -  
40 % Primary funds,  
50 % Secondary funds and  
10 % Street funds

FHWA Pooled Fund project TPF-5(187)

## Updating U.S. Precipitation Frequency Estimates for the Midwestern Region

**Objective:** Determine annual exceedance probabilities and average recurrence intervals for rainfall durations ranging from five minutes to 60 days and frequencies from 1-500 years. The study results will be a web based publication.

**Progress:** In the next reporting period, the peer review of precipitation frequency estimates at base durations (1-hour, 1-day and 10-day) will occur. Hydrometeorological Design Studies Center will review and begin to address any comments received. Additionally, the following tasks will be completed: temporal distribution analysis, seasonality analysis and rainfall frequency analysis. Web publication for precipitation frequency estimates will be complete by March 2013. Area reduction factors will be published by the end of 2013.

**Reports:** None

**Implementation:** The National Weather Service (NWS) rainfall maps have not been updated for approximately 50 years. This means that the designs of storm sewers, culverts, dams, detention basins, etc. have been performed by engineers using outdated data. This project is part of a national effort to update the rainfall/frequency relationships for the entire United States.

Contour maps and high resolution grids will be available for each combination of rainfall frequency and duration. Charts of seasonal distribution of annual rainfall will be developed and documented.



Implementing updated precipitation frequency estimates as a design tool for future projects will help engineers design bridges, culverts, detention basins, storm sewers and other transportation projects more efficiently.

*Photo: NOAA*

## TR-597

**Agency:**

Iowa State University

**Principal****Investigator:**

Neal Hawkins

**Research Period:**

August 1, 2008 –  
July 31, 2011

**Research Board  
Funding:**

\$124,989

**Funding Source:**

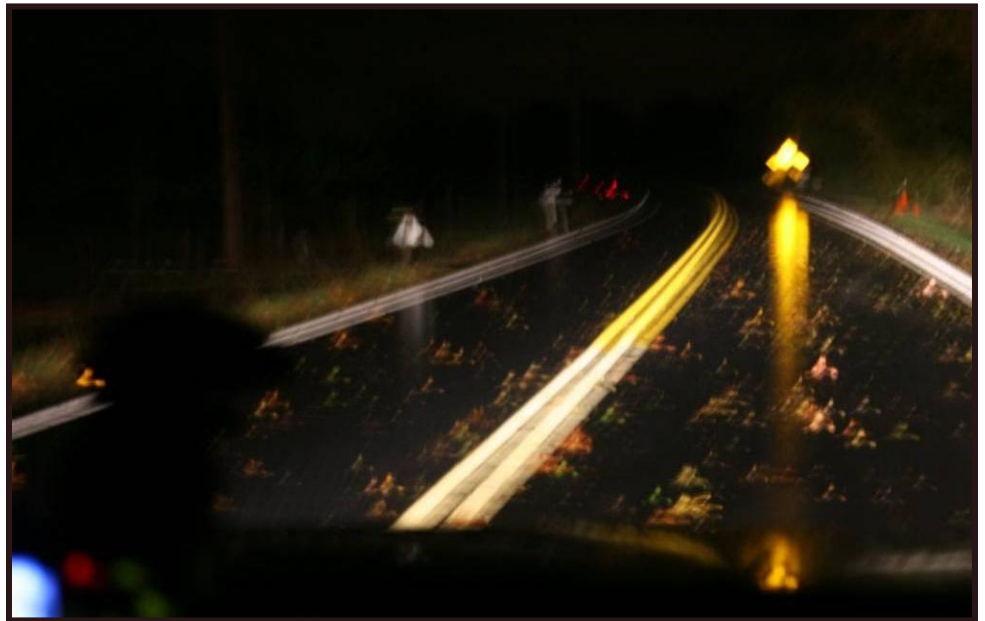
100 % State -  
40 % Primary funds,  
50 % Secondary  
funds and  
10 % Street funds

## Wet Reflective Pavement Marking Demonstration Project

**Objective:** Develop a two year line-test deck allowing the evaluation and demonstration of a variety of wet reflective pavement marking materials and treatments under wet night conditions.

**Reports:** Final Report, December 2011

**Implementation:** Documenting the performance of these various products and treatments will assist the Iowa DOT and local agencies in determining when and where their use might be most effective. Performance parameters will include durability, presence, retro-reflectivity, and wet night visibility.



Wet, dark conditions present special challenges to drivers, such as color variations (shown here between two different centerline pavement marking products used on a rural two-lane roadway). In dry conditions, both products are yellow. However, under wet conditions the nearer product appears white in color (like edge line markings) which is an obvious safety concern.

*Photo: Neal Hawkins, Iowa State University/InTrans*



## TR-598

**Agency:**  
Iowa State University

**Principal Investigator:**  
Charles Jahren

**Research Period:**  
December 1, 2008 –  
September 30, 2010

**Research Board Funding:**  
\$60,000

**Funding Source:**  
100 % State -  
40 % Primary funds,  
50 % Secondary  
funds and  
10 % Street funds

## Development of Updated Specifications for Roadway Rehabilitation Techniques

**Objective:** Create recommendations to improve the SUDAS and Iowa DOT standard specifications, incorporating results of recent research on seal coat, slurry seal, micro-surfacing, and fog sealing; To assess cold in-place recycling and stabilization in the SUDAS manuals and based on input, recommend appropriate additions for cold in-place recycling and modifications to the sections on stabilization.

**Reports:** Final Report, May 2011

**Implementation:** The research findings will be reported as Draft and Final documents for inclusion in the SUDAS Standard Specifications, the SUDAS Design Manual, the Iowa DOT Standard Specifications, the Iowa DOT Materials Instructional Memoranda, and other similar documents.

It is expected that the results of this research can be fully implemented within current SUDAS and Iowa DOT staffing, budgets, and procedures.



A chip spreader applies cover aggregate during a seal coat or "chip seal" operation on 74<sup>th</sup> Street in Cedar Rapids, Iowa, during a road maintenance effort

*Photo: Dr. Charles Jahren, Iowa State University/CCEE*

## TR-601

**Agency:**

Iowa State University

**Principal Investigator:**

Omar Smadi

**Research Period:**

January 1, 2009 –  
September 30, 2011

**Research Board Funding:**

\$100,000

**Funding Source:**

100 % State -  
40 % Primary funds,  
50 % Secondary  
funds and  
10 % Street funds

## Roadway Lighting and Safety: PHASE II – Monitoring, Quality, Durability and Efficiency

**Objective:** Address the quality of lighting rather than just the presence of light with respect to safety. ISU staff are teamed with Virginia Tech Transportation Institute (VTTI) through funding from the National Safety Center. VTTI will replicate Phase I, develop roadway illumination monitoring equipment, and work with ISU to complete objectives to analyze data and establish a relationship between crash performance and illumination at rural, unsignalized intersections. Recommendations to address lighting design and maintenance will be developed.

**Reports:** Final Report, December 2011

**Implementation:** Findings can be incorporated into Chapter 11 of the SUDAS Roadway Lighting Design Manual and will be included in the SUDAS manuals. Presentations will be given at the County Engineer Conference, ASCE Transportation Conference, APWA conference, and through a variety of other professional, municipal, and national group presentations.



Intersection infrastructure and geometry influence lighting levels and corresponding crash rates. Safety recommendations will be established based specifically on lighting levels and related crash data.

*Photo: Dr. Omar Smadi,  
Iowa State University/  
InTrans*



## TR-604

**Agency:**

Iowa State University

**Principal****Investigator:**

Travis Hosteng

**Research Period:**

November 15, 2008 –  
December 31, 2011

**Research Board  
Funding:**

\$88,336

**Funding Source:**

100 % State -  
100 % Secondary  
funds

## Field Testing and Evaluation of a Demonstration Timber Bridge

**Objective:** Perform field testing and evaluation of a glued-laminated timber girder bridge with transverse deck panels and an asphalt wearing surface to assess overall design, construction, and bridge and wearing surface performance. Monitoring systems will be designed and installed on the demonstration field timber bridge to collect overall bridge construction and in-service performance over a period of approximately two years.

Evaluation of performance will be formulated through comparisons with design assumptions, previous research, and existing bridge performance records. The research will be performed through a cooperative effort of researchers at ISU, the United States Department of Agriculture (USDA) Forest Products Laboratory (FPL) and Delaware County Engineering staff.

**Reports:** Final Report February 24, 2012

**Implementation:** The successful development and implantation of deck panel joint details for transverse glued-laminated decks will be useful nationwide for management of timber bridges with asphalt wearing surfaces. The systems may be incorporated into typical standard bridge plans and utilized nationwide for bridge projects.



A demonstration timber bridge was completed in the spring of 2009 in Delaware County, Iowa. It features an innovative deck treatment system.

*Photo: Iowa State University/InTrans, Bridge Engineering Center*

## TR-605

**Agency:**

Iowa State University

**Principal Investigator:**

Terry Wipf

**Research Period:**

November 15, 2008 –  
December 31, 2011

**Research Board Funding:**

\$70,044

**Funding Source:**

100 % State -  
40 % Primary funds,  
50 % Secondary  
funds and  
10 % Street funds

## Evaluation of the Buena Vista IBRD Bridge: A Furthering of Accelerated Bridge Construction in Iowa

**Objective:**

- Assist the Iowa DOT and Iowa County Engineers to fully leverage FHWA Innovative Bridge Research Construction Program funding
- Demonstrate benefits of precast post-tensioned bridge components
- Perform testing and evaluation of precast components for the bridge project in Buena Vista County and assess design, construction, and structural performance
- Design and install monitoring systems and perform structural tests over approximately two years
- Formulate evaluation of performance through comparisons with design assumptions, recognized codes and standards

**Reports:** Final Report February 24, 2012

**Implementation:** The development of precast (and in some cases post-tensioned) bridge components offers the potential to significantly reduce traffic delays and inconvenience to the travelling public, improve safety during construction, resulting in more durable bridges, particularly for low volume roads.



Beam placement during accelerated construction of Buena Vista IBRD bridge

*Photo: Dr. F. Wayne Klaiber, Iowa State University/CCEE*

## TR-606

**Agency:**

Iowa State University

**Principal Investigator:**

Duane Smith

**Research Period:**

February 21, 2009 –  
February 29, 2011

**Research Board Funding:**

\$125,000

**Funding Source:**

100 % State -  
40 % Primary funds,  
50 % Secondary  
funds and  
10 % Street funds

## Iowa Leadership Institute

**Objective:** The Iowa LTAP, in conjunction with Iowa's public agency representatives, continues developing a training program to create better (or new) leaders and supervisors for Iowa's public agencies. Modules are offered for a fee to support future development and administration of the Academy through the Iowa LTAP. The curriculum and course content for ten core modules includes:

- Supervisory Techniques
- Effective Communication
- Community Service Skills
- Resource Management Skills
- Fundamentals of Government
- Basic Management Skills
- Leadership Skills
- Legal Understanding
- Finance
- Operations and Maintenance

**Tasks:** Coordinate Planning and Development Activities; Develop Academy Identity or Theme (Branding); Establish A Marketing Plan; Sequence and Schedule Academy Development; Create Module Content; Present Academy Modules; Integrate the Academy into Conferences and Workshops; Identify Measures of Success and Suggest Peer Exchange Format.

**Reports:** Final Report, September 2011

**Implementation:** The modules are accessible to anyone with an internet connection at [www.ctre.iastate.edu/LTAP](http://www.ctre.iastate.edu/LTAP). Publicity about the program is being handled through the LTAP program.



Leadership Academy Program Coordinator Bob Sperry records an instructional video with Marion County Engineer Roger Schletzbaum and Lorri Jahner, Marion Deputy County Auditor.  
*Photo: Iowa State University*

## TR-608

**Agency:**

Iowa County  
Engineer Association  
Service Bureau

**Principal Investigator:**

Steve DeVries

**Research Period:**

August 1, 2009 –  
December 31, 2012

**Research Board Funding:**

\$154,316

**Funding Source:**

100 % State -  
40 % Primary funds,  
50 % Secondary  
funds and  
10 % Street funds

## Assessment of Iowa County Roadway Financing Needs

**Objective:** Develop a conceptual model to facilitate accurate forecasting simple enough for presentation to the public, also:

- After the conceptual model is defined, physical and financial data will be gathered from public and private sectors and reviewed to identify and quantify interrelationships between the road network, vehicles that operate on it, and land parcels that adjoin it.
- Define a data structure and processing engine that represent road, traffic and land use entities' relationships and affects on each other.

**Progress:** The analysis engine was first completed in July, but substantial test and refinement proved necessary. As a result, it was not finished until 9/30/2012. It is now operational and being used to explore various 'what-if' outcomes. The last remaining tasks are a) direct generation of usable graphics for counties and b) a final report.

**Reports:** None

**Implementation:** The model will assist agencies with estimating the cost of a service level, find what service level fits a particular revenue stream, and project what improvements are needed to meet traffic levels. It will also facilitate study and discussion of tradeoffs between road costs, vehicle costs and land use costs, and identify the value of commerce supported by secondary roads.



## TR-609

**Agency:**

The University of Iowa

**Principal Investigator:**

Hosin David Lee

**Research Period:**

July 16, 2009 –  
December 31, 2011

**Research Board Funding:**

\$104,140

**Funding Source:**

100 % State -  
40 % Primary funds,  
50 % Secondary  
funds and  
10 % Street funds

## Curing Criteria for Cold In-Place Recycling (CIR) – PHASE III

**Objective:** The Objectives of this project are to:

- Measure moisture contents and temperature throughout a CIR layer at six CIR project sites
- Calibrate developed moisture loss indices using field measurements from six CIR project sites
- Develop stiffness/density gain model to supplement (or possibly replace) the moisture criteria

The moisture loss indices will provide data when rationalizing how the quality of CIR layer is inspected for optimum timing of an HMA overlay, and significantly enhance the long-term performance of CIR pavements. In addition, the stiffness of CIR layer measured by the Geo-gage can be used to supplement (or possibly replace) the moisture measurement during a curing period.

**Reports:** Final Report, January 27, 2012

**Implementation:** This research will provide a moisture loss index and/or a stiffness/density gain model to monitor the CIR layer for a timely placement of the wearing surface. A set of curing indices and/or a stiffness/density gain model that can determine an optimum timing of an overlay are expected.



Curing process on Iowa county road before overlay

*Photo: Dr. Hosin "David" Lee, IIHR, The University of Iowa*

## TR-613

**Agency:**

Iowa State University

**Principal****Investigator:**

Terry J. Wipf

**Research Period:**

January 25, 2010 –  
June 30, 2015

**Research Board  
Funding:**

\$153,590

**Funding Source:**

100 % State -  
40 % Primary funds,  
50 % Secondary  
funds and  
10 % Street funds

## Study of the Impacts of Implements of Husbandry on Iowa Bridges

**Objective:** The objective of this study is to determine how the implements of husbandry distribute their load within a bridge structural system and to provide recommendations for accurately analyzing bridges for their loading effects. To achieve this objective the distribution of live load and dynamic impact effects for different types of agricultural vehicles will be determined by load testing and evaluating two general types of bridges. The types of equipment studied will include but is not limited to; grain wagons/grain carts, manure tank wagons, agriculture fertilizer applicators, and tractors. Once the effect of these vehicles has been determined, recommendations for the analysis of bridges for these non-traditional vehicles will be developed.

**Progress:** Several calibrated bridge models have been formalized that will be used in the determination of the rating factors. The project team has completed analyzing the field collected data, creating analytical models for those field tested bridges and computing experimental and analytical distribution factors for those bridges and have also started collecting information on a large number of bridges which will be investigated analytically. Most participating states have provided information.

**Reports:** None

**Implementation:** Engineers involved in the rating/evaluation of bridges for live load performance of bridges will be able to immediately be able to use the resulting information as the results will be given in a format commonly used by practicing engineers. The results of this study will most likely supplement existing standards by providing information/guidance not previously available.

## TR-614

**Agency:**

Iowa State University

**Principal Investigator:**

Sri Sritharan

**Research Period:**

November 20, 2009 –  
December 31, 2011

**Research Board Funding:**

\$50,000

**Funding Source:**

100 % State -  
40 % Primary funds,  
50 % Secondary  
funds and  
10 % Street funds

## Structural Characterization of a UHPC Waffle Bridge Deck and its Connections

**Objective:** The objectives of this proposed research is to perform structural characterization of the UHPC waffle bridge deck panel designed for the bridge in Wapello County and its critical connections, and evaluate the system performance and ride ability of the panel top surface.

**Progress:** The Phase 1 Report, which is on the laboratory testing of the UHPC waffle deck, has been completed. The feedback received on the report from TAC and representatives of FHWA's Highway for LIFE program have been incorporated. FHWA has approved the final version of the Phase 1 report, thereby giving authorization for the production of UHPC panels for the field implementation which will take place in the next phase. The final report to IHRB will combine both Phase I and Phase II studies.

Construction of the prototype bridge was delayed, but was completed in Fall 2011. Field testing of the Wapello County Bridge was completed in March 2012. The draft of the Phase-II report presenting the analysis and results from the field testing data was submitted to the Coreslab Structures Inc. for review comments. Following analysis of field data, the draft version of the Final report to IHRB has been completed. The final report is anticipated to be completed by end of December 2012.

**Reports:** None

**Implementation:** The research findings of the project will be disseminated to designers and practitioners in the fields of structural and construction engineering.

## TR-615

**Agency:**

Iowa State University

**Principal****Investigator:**

Sri Sritharan

**Research Period:**

December 17, 2009 –  
December 31, 2012

**Research Board  
Funding:**

\$210,000

**Funding Source:**

100 % State -  
40 % Primary funds,  
50 % Secondary  
funds and  
10 % Street funds

## Connection Details and Field Implementation of UHPC Piles - Phase II: Use of Ultra-High Performance Concrete in Geotechnical and Substructure Applications

**Objective:** The objectives chosen for the next phase of the project are to:

1) establish and test connection details to extend the length of UHPC piles in the field; 2) develop and test suitable details that can be used to connect the UHPC pile to concrete pile cap as well as to bridge abutment; 3) study a UHPC pile behavior as part of a bridge foundation in the field and compare its behavior to that of a steel H pile, and 4) develop a preliminary geotechnical design methodology.

**Progress:** The instrumented steel HP 10 x 57 piles have been driven.

The first UHPC production pile was broken after falling from the crane and deemed unusable for the bridge. A new pick-up point was devised for the UHPC pile using a threaded rod, washers and nuts. The second production pile was instrumented and driven. All piles in the field and all the pile-to-cap connections in the laboratory have been completed. Data reduction from the tests is currently underway. Field monitoring of the piles are currently underway

**Reports:** None

**Implementation:** This research will contribute to establishing a cost-effective, durable pile for bridge infrastructure. The proposed laboratory tests will allow UHPC piles to be effectively extended without causing any construction delays, while the connection tests will establish details for anchoring the pile into pile caps and abutments, which may also be used for steel piles. The planned field tests will not only confirm the expected behavior of the UHPC piles under real-world loading conditions, but will also create unique data that will enable preliminary evaluations to be completed on LRFD design of UHPC piles, examination of the effects of setup and understanding the potential benefits of construction control for this pile type.



## TR-616

**Agency:**

Iowa State University

**Principal****Investigator:**

Brent Phares

**Research Period:**

August 7, 2010 –  
January 31, 2012

**Research Board  
Funding:**

\$150,843

**Funding Source:**

100 % State -  
40 % Primary funds,  
50 % Secondary  
funds and  
10 % Street funds

## Timber Abutment Piling and Back Wall Rehabilitation and Repair

**Objective:** The objectives of this investigation are to:

- review existing products for timber preservation and repair and to document their effectiveness in extending the life expectancy of various bridge components.
- determine techniques used by county engineers and other engineers to repair and restore load carrying capacity of piling damaged by deterioration and cracking.
- review methods used to repair failed piling.
- determine/develop effective methods for transferring bridge loads through the failed portion of the pile.
- determine that safe load capacity is restored by the repair methods (existing or new) determined to be structurally efficient.

**Reports:** Final Report, September 2012

**Implementation:** The identification of effective existing systems and new systems for the strengthening/rehabilitating timber substructure elements offers significant benefits to the State of Iowa. Close to 25% of the bridges on LVRs are structurally deficient. Many of these have sound superstructure elements and deficient timber substructure elements. By rehabilitating or strengthening the deficient timber substructure elements, one creates a significant cost savings by extending the life of the bridge.

## TR-617

**Agency:**

The University of  
Iowa

**Principal  
Investigator:**

Thanos Papanicolaou

**Research Period:**

June 1, 2010 –  
December 31, 2012

**Research Board  
Funding:**

\$170,866

**Funding Source:**

100 % State -  
40 % Primary funds,  
50 % Secondary  
funds and  
10 % Street funds

## An Adaptive Field Detection Method for Bridge Scour Monitoring Using Motion-Sensing Radio Transponders (RFIDs)

**Objective:** The objective is to utilize Motion-Sensing Radio

Transponders (RFIDS) on fully adaptive bridge monitoring and residual life prediction to minimize the problems inherent in human inspections of bridges. This will include an integrated condition-based maintenance (CBM) framework integrating RFID sensors and sensing architecture, for in-situ scour monitoring of critically scoured bridge structures. This will provide real-time state awareness datasets that can be used in making decisions on down time, repair cost, and functionality.

**Progress:** The project was extended until December 31, 2012. There is a modification of the reader software to improve data recording by adding some new features such as options to record sequential readings and perform plots of the signal intensity. The new software provides the ID of the transponder; its location and signal reader strength; records sequential readings and performs plots of the signal intensity. The final report is currently being written.

**Reports:** None

**Implementation:** The need for maintenance personnel to be present at a bridge site could be removed by automating the collection and transmission of scour data, thereby making the scour-monitoring process safer and more efficient. An RFID system fitted with data telemetry equipment can provide the ability to collect and transmit data to a maintenance office. Remote monitoring could mitigate the inefficiencies and dangers inherent in the current practices, as well as provide early warning of impending bridge failure and the ability to track long-term degradation as a result of scouring.

Additional benefits of remote monitoring include the potential reduction in the labor required to perform monitoring, and the acquisition of real-time data for calibrating scour prediction equations and enhancing the state of knowledge about the scour-monitoring process.

## TR-619

**Agency:**

The University of  
Iowa

**Principal  
Investigator:**

Marian Muste

**Research Period:**

April 1, 2010 –  
January 31, 2012

**Research Board  
Funding:**

\$156,159

**Funding Source:**

100 % State -  
40 % Primary funds,  
50 % Secondary  
funds and  
10 % Street funds

## Development of Self-Cleaning Box Culvert Design - Phase II

**Objective:** The overall objective of this project is to identify and/or develop methods for constructing, or retro-fitting, box culverts so that the typical flow through a culvert will clean the culvert's entrance area and the barrels and keep the structure performing well with little or no maintenance. The new phase of the study will include, but not be limited to, preparing the implementation phase for the self-cleaning design at selected sites in Iowa and continue the multi-prong research on self-cleaning designs for other types of culverts, besides the 3-box culvert investigated in TR 545.

**Progress:** The routine monitoring at the Hwy 1 three-box culvert has been continued as planned. A real-time web camera is in place for continuous monitoring of the sedimentation development and real-time stream-gage sensor is also operating continuously for flow monitoring.

The research team presented a progress report to TAC on August 28, 2012. The meeting reviewed the monitoring progress. The low flow situation during the spring and summer seasons has not developed major changes in the sediment deposits. However, vegetation growth produced some morphology changes that are expected to further trigger sedimentation with the first rain events.

The drawings for construction of the fillets were executed by Iowa DOT and Iowa City. They were reviewed by our team and brought as much as possible to the modeled configuration. Currently the bidding for the construction of the fillets is in progress.

**Reports:** None

**Implementation:** The primary products of the project would be a practical report that provides design layouts and guidance for self-cleansing methods for use for new culverts and for retrofitting to existing culverts known to have a sedimentation problem. The report prepared will be formatted in a comprehensive and well-illustrated manner that directly helps engineers to select the self-cleansing method best suited for a culvert site.

## TR-620

**Agency:**

Foth Infrastructure

**Research Period:**

July 26, 2010 –

August 31, 2011

**Research Board****Funding:**

\$339,471

**Funding Source:**

100 % State -

40 % Primary funds,

50 % Secondary  
funds and

10 % Street funds

## Update of Reinforced Concrete Box (RCB) Culvert Standards to LRFD Specifications

**Objective:** The objectives of the project involve developing software that will design the RCB culvert barrel sections. Using the software, the consultant will design and develop RCB culvert standards to LRFD specifications for single, twin and triple box culverts.

**Progress:** Barrel Standards are complete and have been submitted to the Iowa DOT Office of Bridges and Structures for approval. Headwall standards are currently being designed and detailed. Additional funding has been approved for the addition of a rating component to be added to the design software.

**Reports:** Final Report, June 29, 2012

**Implementation:** Updated standards are available at:  
<http://www.iowadot.gov/bridge/v8elrfdculstd.html>

## TR-621

**Agency:**

Iowa State University

**Principal Investigator:**

David White

**Research Period:**

July 9, 2010 –  
December 31, 2011

**Research Board Funding:**

\$81,500

**Funding Source:**

100 % State -  
40 % Primary funds,  
50 % Secondary  
funds and  
10 % Street funds

## Geo-synthetic Reinforced Soil (GRS) for Low Volume Bridge Abutments

**Objective:** The objectives of this project are to:

1. Develop an instrumentation and monitoring plan to evaluate performance of newly constructed GRS bridge abutment systems.
2. Develop a design approach and construction guidelines for GRS bridge abutment systems with shallow spread footings on LVR bridges.
3. Document and evaluate the cost and construction aspects associated with construction of GRS bridge abutment systems from detailed field observations on project sites.
4. Produce a research report and technology transfer materials that provide recommendations for use and potential limitations of GRS bridge abutment systems.

**Reports:** Final Report, January 27, 2012

**Implementation:** The observations and conclusions from this study will provide recommendations for use of sheet pile abutments in LVRs and in-situ soil testing. County engineers can implement the recommendations for use of an alternative abutment system.

## TR-622

**Agency:**

Wiss, Janey, Elstner  
and Associates (WJE)

**Principal  
Investigator:**

Wade Clarke

**Research Period:**

August 1, 2010 –  
July 31, 2012

**Research Board  
Funding:**

\$134,442

**Funding Source:**

100 % State -  
40 % Primary funds,  
50 % Secondary  
funds and  
10 % Street funds

## Maintenance and Design of Steel Abutment Piles in Iowa Bridges

**Objective:** The desired outcome of this research will yield

1. Methods for addressing the problem of pile corrosion in existing bridges, and
2. A cost effective design methodology to prevent steel pile corrosion from occurring in new bridges in the future.

In addressing cost effective methods to prevent steel pile corrosion in new bridges, corrosion protection strategies will be developed that can be readily incorporated into contract specifications. These methods can be used and evaluated on upcoming bridge construction projects where steel pile corrosion is a concern.

**Progress:** WJE has completed the laboratory testing for this project and selected coatings for field application. Coatings have been ordered for field application. WJE has also selected a controlled low-strength material mix and admixture for use in conjunction with the cathodic protection (CP) system. Field work for both the field CP and field coating tests may be completed this fall if the contractor is able to schedule the work before the weather gets too cold. The final report will be completed approximately six to eight weeks after the field work is complete.

**Reports:** None

**Implementation:** The project recommendations can be immediately implemented as changes to bridge construction specifications and specifications in maintenance contracts for existing structure repairs or preventive maintenance. Further, the work will provide a basis to develop recommendations to Iowa DOT maintenance staff to assist with optimizing the maintenance of bridge foundations.

## TR-623

**Agency:**

Iowa State University

**Principal Investigator:**

Chris Williams

**Research Period:**

August 1, 2010 –  
July 31, 2012

**Research Board Funding:**

\$150,742

**Funding Source:**

100 % State -  
40 % Primary funds,  
50 % Secondary  
funds and  
10 % Street funds

## Quality Control/Quality Assurance Testing for Joint Density and Segregation of Asphalt Mixtures

**Objective:** The objectives for this project are to identify best practices for joint geometry, joint construction, and for minimizing segregation. Field testing of asphalt pavements during construction as well as existing pavement sections exhibiting open longitudinal joints will be investigated. The project will concurrently compare and evaluate destructive and non-destructive testing methods for identifying segregation and quality control/quality assurance of centerline joints. Testing criteria will then be developed for the most suitable method.” Additionally, a test method that can be used to evaluate the permeability of mixtures during the mix design phase will be included.

**Progress:** The research team has continued with the analysis of the data collected on the 2011 construction projects. Additional projects from 2012 continue to support the data from the 2011 construction season. Lab testing of the materials is nearly complete and a substantial amount of the analysis has been completed too.

The research from the 2011 construction season data shows premature longitudinal joint failures are a result of a combination of low density, high permeability, segregation and lack of joint adhesion.

**Reports:** None

**Implementation:** The implementation and technology transfer aspects of the project will include the specific items stated in the products above and in particular: (1) The development of draft test methods for laboratory and field permeability testing. (2) Development of draft permeability quality assurance criteria for inclusion in percent within limit specifications.

## TR-624

**Agency:**

The University of  
Iowa

**Principal  
Investigator:**

Hosin David Lee

**Research Period:**

August 1, 2010 –  
July 31, 2012

**Research Board  
Funding:**

\$150,000

**Funding Source:**

100 % State -  
40 % Primary funds,  
50 % Secondary  
funds and  
10 % Street funds

## Development of Quality Standards for Inclusion of High Recycled Asphalt Pavement Content in Asphalt Mixtures

**Objective:** The objective of this project is to develop quality standards for inclusion of high RAP content in asphalt mixtures.

Performance testing and asphalt binder testing will be performed at all temperature regimes to characterize the binder contained in RAP and whether or not results are source dependent. Both laboratory and plant produced mixtures will be examined, which would help answer the question that how much blending occurs between the binder in RAP and virgin binder. In addition, this study will explore the possible role that fractionation may take in increasing RAP usage.

**Progress:** Due to the difficulty in identifying the test section, test sections were not be constructed with varying RAP/FRAP contents as originally proposed. The project duration was extended to December 31, 2012. Laboratory samples were prepared for testing dynamic modulus and flow number. The Laboratory testing will replace the anticipated field testing.

**Reports:** None

**Implementation:** The implementation outlook for this research effort is very realistic given an increasing number of construction projects of asphalt pavements with RAP in Iowa. The results of this study shall provide a new mix design process with high RAP/Fractionated RAP contents.



## TR-625

**Agency:**

Iowa State University

**Principal Investigator:**

Sri Sritharan

**Research Period:**

November 1, 2010 –  
December 31, 2012

**Research Board Funding:**

\$250,000

**Funding Source:**

100 % State -  
40 % Primary funds,  
50 % Secondary  
funds and  
10 % Street funds

## Improving Accuracy of Deflection & Camber Predictions for Pre-stressed Concrete Bridge Girders

**Objective:** The primary objective of the proposed research is to provide accurate methods for predicting short-term and time dependent camber during design and, if desired, means of increasing camber for prestressed beams fabricated for Iowa bridges. The approach will be to evaluate existing data and models as well as to systematically understand instantaneous and time dependent components of camber from casting of the PPCBs to construction of the actual bridge and beyond by quantifying the most significant parameters affecting camber of beams used in Iowa.

**Progress:** A summary of the project progress is as follows: 1) review of literature has focused on creep and shrinkage of concrete, prediction of camber using methods recommended for design practice and finite element modeling of prestressed beams; 2) Gathering of data has focused on historical information collected by precast plants and district engineers; 3) several camber measurements techniques have been studied and decided that a tape measure, a digital level, and a string potentiometer measurement system will be deployed to accurately capture the camber at precast plants; 4) several camber measurements have been taken from precast beams from Andrews Precast, Coreslab Precast, and IPC Precast; 5) detailed analysis of beams are currently underway to evaluate the cause of discrepancy between measured and expected camber using the design equations; 6) measuring and monitoring of four state bridge projects is being pursued. Three bridge projects are complete and long-term camber is currently being monitored on each of these along with the girders from the fourth project; and 8) work on the final report is started.

**Reports:** None

**Implementation:** Better understanding of camber behavior and improved predictive tools will facilitate smooth construction, avoid difficult field problems for which there may be no good solution, ensure better service performance, and ultimately reduce life-cycle costs for Iowa's prestressed bridge inventory.

## TR-626

**Agency:**

The University of  
Iowa

**Principal  
Investigator:**

George  
Constantinescu

**Research Period:**

October 15, 2010 –  
June 30, 2012

**Research Board  
Funding:**

\$151,430

**Funding Source:**

100 % State -  
40 % Primary funds,  
50 % Secondary  
funds and  
10 % Street funds

## Optimization of Snow Drifting Mitigation & Control Methods for Iowa Conditions

**Objective:** The overarching goal of the present proposal is to optimize the design of passive snow-control measures for Iowa roadways such that the impact of drifting on the roads is minimized or eliminated. The focus of the research will be on providing optimized solutions for limited-area right of ways and topographies which are favoring snow drifting on roadways. This design optimization should result in cost-effective solutions to the snow drift problem that can be tailored for weather and road conditions that are the most common for the Iowa environment.

**Progress:** The snow events for 2011/2012 did not result in significant snow deposition. Given the lack of validation data during the winter of 2012, the study was extended to another winter and it was expanded to include living snow fences.

As the continuation of the work performed as part of the present project (Part I), it was decided after consultation with the Iowa DOT project manager to submit a final report at the conclusion of the second part of the project. Presently, the project team is working with the TAC committee to identify sites where monitoring of living snow fences will be done. The monitoring of structural snow fences at the Williams site will be continued. A major development in terms of field monitoring of deposits will be to obtain quantitative information of snow deposit in time. The project team is in the process of deciding what software to acquire for this purpose.

**Reports:** None

**Implementation:** A series of practical recommendations will be compiled by the project team to include the findings of the study in the Iowa snow fence design guidelines and illustrate the lifecycle cost benefits resulting from the new design implementation. The test cases and set up of the numerical model will be made available to IDOT for future use in new situations where the space constraints and local topography are of concern for the design of snow fences.

## TR-627

**Agency:**

Iowa State University

**Principal Investigator:**

Kelly Strong

**Research Period:**

November 1, 2011 –  
May 31, 2012

**Research Board Funding:**

\$79,826

**Funding Source:**

100 % State -  
40 % Primary funds,  
50 % Secondary  
funds and  
10 % Street funds

## Risk Mitigation Strategies for Operations and Maintenance Activities

**Objective:** The objective of this research is to investigate the application of integrated risk modeling to Operations/Maintenance activities, specifically moving operations such as pavement testing, pavement marking, painting, snow removal, shoulder work, mowing, etc. The ultimate goal is to reduce frequency and intensity of loss events (property damage, personal injury, and fatality) during operations and maintenance activities.

After potential risk factors have been identified and loss severity has been evaluated, the research team will identify risk mitigation strategies that can be used within integrated teams to reduce the frequency and/or severity of losses during Operations/Maintenance activities.

**Reports:** Final Report, April 27, 2012

**Implementation:** The general form of the research findings will be a process map or guidebook for use by the Iowa DOT, Iowa County Engineers, and municipal transportation agencies to assess the risk potential of various operations and maintenance activities and develop team-based risk mitigation strategies.

## TR-629

**Agency:**

Iowa State University

**Principal Investigator:**

Neal Hawkins

**Research Period:**

March 1, 2011 –  
August 31, 2012

**Research Board Funding:**

\$75,000

**Funding Source:**

100 % State -  
40 % Primary funds,  
50 % Secondary  
funds and  
10 % Street funds

## Revision to the SUDAS Traffic signal Standards Phase II

**Objective:** The objectives of this project are:

1. Update all of the existing SUDAS traffic signal specifications figures
2. Conduct a structural review of footing steel and concrete capacities and standards and incorporate this information into the SUDAS Design Manual
3. Develop and include non-proprietary, performance based NEMA and Type 170 controller and cabinet specifications
4. Develop and include non-proprietary fiber optic cable, modem, and communications specifications
5. Develop and include non-proprietary video monitoring/camera specifications

**Reports:** Final Report June 1, 2012

**Implementation:** The findings of this research will be shared through incorporation into the SUDAS manuals as well as through presentations at the Iowa county engineer's conference, MOVITE Traffic Engineering Conference, ASCE Transportation Conference, Iowa Chapter APWA conference, and through a variety of other professional, municipal, and national group presentations. This information will be disseminated and available for use by all agencies that use the SUDAS manuals.

## TR-630

**Agency:**

Iowa State University

**Principal Investigator:**

Shauna Hallmark

**Research Period:**

January 15, 2011 –  
December 31, 2012

**Research Board Funding:**

\$55,000

**Funding Source:**

100 % State -  
40 % Primary funds,  
50 % Secondary  
funds and  
10 % Street funds

## Evaluation and Guidance on Effective Traffic Calming for Small Communities

**Objective:** The objectives of this study are:

- Summarize information about effective transition zone planning and design practice
- Identify and summarize techniques used to manage speeds in transition zones
- Demonstrate the effectiveness of techniques that are practical for high- to low-speed transition zones
- Acquire additional information about techniques that may show promise but lack sufficient evidence of effectiveness
- Develop an application toolbox to assist small communities in selecting appropriate transition zones and selecting effective techniques for transitioning from high-speed to low-speed roadways

**Progress:** Treatments were installed in St. Charles at all 4 community entrances. Temporary curbing was installed at the north, south, and west community entrances and an LED speed sign was installed at the east entrance. The Buchanan county engineer was planning to install a speed sign in Rowley, Iowa. The team worked with Buchanan County to investigate the site. This location will now be included in the study. The team conducted a before speed study and assisted with the installation of the sign.

Before data was collected St. Charles and Rowley. 1-month after data was collected in all communities. Most of the speed data have been reduced. A draft toolbox has been developed. The project team is currently looking for additional treatments to include.

**Reports:** None

**Implementation:** The findings from this research will enable practitioners to better design speed transition areas from high- to low-speed roadways, determine when speed management is necessary, and then select and monitor appropriate techniques. This capability is expected to have an impact at the national, state, and local level.

## TR-631

**Agency:**

Iowa State University

**Principal Investigator:**

Brian Gelder

**Research Period:**

April 1, 2011 –  
January 31, 2014

**Research Board Funding:**

\$73,873

**Funding Source:**

100 % State -  
40 % Primary funds,  
50 % Secondary  
funds and  
10 % Street funds

## Automation of Digital Element Model (DEM) Cutting for Hydrologic/Hydraulic Modeling

**Objective:** The primary objectives for this project are:

- Develop and program algorithms to enforce fine scale drainage on LiDAR DEMs for the state
- Accurately enforce drainage on catchments larger than 24 acres in conjunction with the Iowa Department of Natural Resources (DNR) and Iowa Institute for Hydraulic Research

**Progress:** Most of the tasks are nearly complete and are waiting upon completion of the IA DNR project. The IA DNR portion of the project, enforcement of channelized streams, is nearly complete and a final version will be complete within the coming month, allowing the DOT project to proceed to completion. The project investigator plans to arrange another TAC meeting for early 2013 to discuss the current status of the project and determine where to best focus remaining work. With the current status of the project, no extension requests are expected. However, additional work to derive additional watershed characteristics may be requested and will be discussed with the TAC at the next meeting.

**Reports:** None

**Implementation:** These DEMs will be used by bridge and culvert engineers during initial design as well as by city and county engineers to correctly contributing area and the hydrologic characteristics of the contributing area as they design water conveyance structures. The actual algorithms for DEM enforcement are not likely to be used by the practicing engineer or administrator but will likely be used by DOT GIS professionals to support LiDAR database maintenance.

## TR-632

**Agency:**

Iowa State University

**Principal****Investigator:**

David White

**Research Period:**

July 1, 2011 –  
June 30, 2012

**Research Board****Funding:**

\$50,000

**Funding Source:**

100 % State -  
40 % Primary funds,  
50 % Secondary  
funds and  
10 % Street funds

## Low Cost Rural Road Surface Alternatives

**Objective:** The proposed objectives of this research project are to:

- (a) Conduct a comprehensive literature survey of the state of practice for granular surface road construction with respect to freeze/thaw damage resistance
- (b) Develop recommendations with respect to conducting a phase 2 study to demonstrate various technologies.

**Progress:** A database of literature pertaining to the stabilization of low-volume roads and granular surfaced roads with an emphasis on increasing freeze-thaw durability has been compiled. Each individual document within the database is currently being assessed and rated for its applicability to the project objective. Results from the assessment will be used to populate the literature summary table and annotated bibliography.

The research team continued the literature review process. The reference management tools initiated during the previous quarter were further explored to assist with the annotation and automatic referencing of documents. The final report is being prepared and is about 50% completed.

**Reports:** None

**Implementation:** The benefits from this project will be to provide improved knowledge in the state-of-the practice for granular surface stabilization. The project will result in improved decision making and investment.



## TR-633

**Agency:**

Iowa State University

**Principal Investigator:**

Kejin Wang

**Research Period:**

August 1, 2011 –  
January 31, 2013

**Research Board Funding:**

\$125,000

**Funding Source:**

100 % State -  
40 % Primary funds,  
50 % Secondary  
funds and  
10 % Street funds

## Investigation into Shrinkage of High Performance Concrete Used for Iowa Bridge Decks and Overlays

**Objective:** The main objective of the proposed study is to investigate the shrinkage behavior of HPC used for Iowa bridge decks and bridge deck overlays. The specific objectives of this investigation include:

- (1) To identify major components of shrinkages (chemical, autogenous, and drying shrinkages) in Iowa concretes;
- (2) To evaluate the influence of various constituent materials, such as types and contents of cementitious material and aggregate, and admixtures, on these shrinkages; and
- (3) To provide recommendations for improving Iowa HPC mix design and construction practice so as to reduce the concrete shrinkage cracking potential.

**Progress:** The progress of activities is as follows:

- Completed all ring shrinkage tests and data plots. It was found that Mixes 2 and 5 had one sample broken during the tests because of the sample handling and one sample had no change in strain gage readings with time. Therefore, the project team will re-do the ring tests for these two mixes.
- Completed casting of all samples for elastic modulus, compressive and splitting strength tests. The measurements of these tests are in progress
- Completed preliminary analysis of the shrinkage test data. It was found that among the 11 mixes studied, two mixes cracked, which had the highest cementitious material contents but not the highest shrinkage values. Further analysis of the data is still continuing.
- Drafted the project report (70% done)

**Reports:** None

**Implementation:** Early age cracking in concrete due to excessive shrinkage is often reported by state DOTs, and the problem is a special concern for HPC used for bridge deck and bridge deck overlays. The most effective way to solve this problem is to select proper concrete materials and mix proportions so that the concrete will have a low tendency to shrink and/or to crack. The observations and conclusions from this proposed study will lead to valuable recommendations on HPC material selection and mix design to reduce the concrete shrinkage cracking potential.

## TR-634

**Agency:**

Iowa State University

**Principal****Investigator:**

Charles Jahren

**Research Period:**

July 1, 2011 –  
June 30, 2012

**Research Board  
Funding:**

\$85,920

**Funding Source:**

100 % State -  
40 % Primary funds,  
50 % Secondary  
funds and  
10 % Street funds

## Pilot Construction for Granular Shoulder Stabilization

**Objective:** The objective of the proposed research project is to assist Iowa DOT in cost effectively mitigating edge ruts on granular shoulders by pilot testing the use of DUSTLOCK in a full scale maintenance setting and continuing to explore other alternatives such as developing standard specifications for a class of products that might have similar effectiveness and using other stabilizing strategies or paving short sections of shoulders.

**Progress:** The project is complete and the final report is being written. A final project meeting is scheduled for December 2012.

**Reports:** None

**Implementation:** The observations and conclusions from this study will provide recommendations on products and procedures available to mitigate edge rut problems for granular shoulders. In particular the use of DUSTLOCK will be investigated as a pilot construction project. State, county, and city transportation agencies/ jurisdictions can implement these recommendations. The results of this research could improve the behavior of granular shoulders, and reduce its maintenance cost.

Full implementation of possible recommendations may require the purchase of new equipment in order to perform the stabilization process. Alternatively, it may be possible to rent equipment or contract out certain operations. Changes for stabilization agent purchasing processes may be necessary to properly specify stabilization agents or to purchase proprietary materials. It is expected that researchers will be able to assist the Iowa DOT with these issues within the scope of this proposal.

## TR-635

**Agency:**

Iowa State University

**Principal Investigator:**

Chris Williams

**Research Period:**

June 1, 2011 –  
May 31, 2013

**Research Board Funding:**

\$174,991

**Funding Source:**

100 % State -  
40 % Primary funds,  
50 % Secondary  
funds and  
10 % Street funds

## Warm Mix Asphalt Phase II: Evaluation of WMA Quality Assurance Testing Protocols

**Objective:** Phase II of this study will evaluate the performance of plant-produced WMA mixtures as compared to HMA using NCHRP 9-43 recommendations. Other objectives involving curing behavior, quality assurance testing, and hybrid technologies are outlined as follows:

1. Compare the predicted and observed field performance of existing WMA trials produced in the previous Phase I study to that of HMA control sections to determine if Phase I conclusions are translating to the field.
2. Identify any curing effect (and timing of the effect) of WMA mixtures and binders in the field. Determine how the field compacted mixture properties and recovered binder properties of WMA compares to those of HMA over time for technologies common to Iowa.
3. Identify protocols for WMA sample preparation for volumetric and performance testing which best simulate field conditions.

**Progress:** All field sections were surveyed for the 2012 season and additional field analysis is currently in progress. Additional samples were produced in the laboratory from mix previously collected in the field during prior construction seasons. The samples are produced from mixes representing various regions within the state of Iowa and they incorporate various types of commonly used warm mix technologies, varying amounts of recycled asphalt pavement and a mix which contains multiple levels of shingles used in conjunction with WMA.

The sample density was evaluated. This allows for the density of the entire core to be measured as well as the density within just the top layers of the roadway. AASHTO T-283 testing for all core samples has been completed.

**Reports:** None

**Implementation:** WMA technology may have benefits in providing longer haul distances and or longer construction seasons as well as the ability to place thicker lifts. Lastly, it may also be possible to incorporate higher percentages of RAP although this will need to be carefully examined as to the effect on binder grade selection via reduced aging in production/construction of the virgin binder.

## TR-636

**Agency:**

Iowa State University,  
the University of  
Iowa, the University  
of Northern Iowa

**Principal Investigator:**

Brent Phares

**Research Period:**

September 1, 2011 –  
August 31, 2013

**Research Board Funding:**

\$303,433

**Funding Source:**

100 % State -  
40 % Primary funds,  
50 % Secondary  
funds and  
10 % Street funds

## Bridge Damage Detection: Integration of Structural Health Monitoring System Concepts and Components – A Statewide Collaboration

**Objective:** The objectives are:

- 1: Final development of the overall SHM system hardware and software
- 2: Integration of vibration-based measurements into current damage detection algorithm
- 3: Evaluation and development of energy harvesting techniques

**Progress:** There has been significant communication between all the universities with the bulk of the effort/communication driven by the field implementation. The project team finalized the installation of the hardware components necessary of the system. Additionally, the team induced artificial damage into the first sacrificial specimen. Work has continued on the energy harvesting system. It is anticipated that, in the upcoming quarter, additional damage will be induced and the system will be installed.

**Reports:** None

**Implementation:** The area of Structural Health Monitoring has been of significant interest to the Iowa DOT and several Iowa Counties for many years. This is especially true as the DOT moves toward collecting and using more real-time data on the state of the transportation system. This interest and the representation of various DOT offices on the project TAC will ensure a successful completion of the project and implementation of its findings.

Since this topic also has implications to other nearby states, it is anticipated that many other states and counties will be interested in the results of the project. These results will be distributed to the engineering community through the publication of technical papers in the engineering press, and presentations at bridge and transportation conferences and workshops. Posting of pertinent information on the websites of the participating organizations will be made.

## TR-638

**Agency:**

Iowa State University

**Principal Investigator:**

David White

**Research Period:**

June 1, 2011 –  
May 31, 2013

**Research Board Funding:**

\$100,000

**Funding Source:**

50% Federal – SPR  
50 % State -  
40 % Primary funds,  
50 % Secondary  
funds and  
10 % Street funds

## Western Iowa Missouri River Flooding — Geo-Infrastructure Damage Assessment, Repair and Mitigation Strategies

**Objective:** The objectives of this research project are:

1. Field Reconnaissance — Review the geotechnical problems and challenges in the affected counties and cities, and prioritize areas for detailed in-situ testing and evaluation.
2. In-Situ Testing and Evaluation — Conduct in-situ testing to conduct a geotechnical assessment of the flood affected areas. The in-situ testing will focus on:
  - a. Evaluating roadway support capacities (both paved and unpaved roads)
  - b. Evaluating embankment conditions (slope failures)
  - c. Identifying settlement problems along roadway segments, and around bridge abutments and culverts.
3. Field Data Report, Repair and Mitigation Strategies, and Recommendations — Develop a field data report, provide repair and mitigation strategies depending on the assessment of the level and extent of the damage, and recommendations for geo-infrastructure monitoring.
4. Guide for Geo-Infrastructure Flood Damage Assessment and Repair Solutions — Develop the emergency response criteria and guidelines for evaluating geo-infrastructure and recommending repair solutions following a flood event.

**Progress:** Results from Pottawattamie and Fremont county sites were analyzed. The research team also worked on the final report with detailed results, findings, and recommendations. The report is about 70% finished.

**Reports:** None

**Implementation:** The guide's intent is to be used by the County and City Engineers to prepare emergency response plans for future flood events. It will highlight important geo-infrastructure criteria and technologies for damage assessment, emergency response, and repair options. The details of the manual will be developed as an outcome from the research. A detailed data report with lessons learned, repair solutions, and recommendations for geo-infrastructure continuous monitoring will also be provided.

## TR-639

**Agency:**

Iowa State University

**Principal****Investigator:**

Chris Williams

**Research Period:**

November 22, 2011 –  
April 30, 2013

**Research Board****Funding:**

\$149,958

**Funding Source:**

100 % State -  
40 % Primary funds,  
50 % Secondary  
funds and  
10 % Street funds

## Development of Bio-Based Polymers for Use in Asphalt

**Objective:** The objectives of this project are to:

- Identify the most promising polymerization chemistries for forming linear-chain polymers from vegetable oils.
- Identify the triglycerides most amenable to such polymerization and collaborate with plant scientists to identify/develop agricultural feedstock best suited to express these.
- Develop the structure-property relationships crucial to the use of soybean-oil based thermoplastics in applications currently dominated by petrochemically-derived polymers.

**Progress:** The research team has synthesized multiple biopolymers using atom transfer radical polymerization (ATRP) and characterized them rheologically. The research team has blended two Kraton polymers (1101 and 1118) with asphalt binder supplied by Flint Hills (PG52-34). The blending has included multiple percentages of the two Kraton polymers and included full binder characterization. Blending of ATRP polymers with the asphalt and subsequent rheological characterization has been done too.

All asphalt-polymer blends were prepared with a base asphalt modified with 3% polymer. Rheology test results show the ability of the biopolymer to widen the grade range of asphalt almost identically as the commercially available SBS polymers, with the exception of increasing the low critical temperature 1.4°C higher than the D1118 SBS polymer. The Multiple Stress Creep Recovery (MSCR) test results also show the biopolymer can lower the J<sub>nr</sub> value as low as the two commercially available SBS polymers can.

**Reports:** None

**Implementation:** The benefits of this research are potentially utilizing Iowa source materials (e.g. soybean oil) for producing biopolymers for use in Iowa asphalt binders. Current market analysis illustrates that the material cost of the biopolymers is 40 percent lower than using butadiene with additional savings being provided via lower production costs. These lower costs will translate into lower costs of polymer modified asphalt. The handling of vegetable oils in producing the bioelastomers and subsequent linking with styrene is also much safer and has less impact on the environment. This should also create improved economic opportunities for soybeans resulting in economic value to the State of Iowa and maintaining soil qualities through a balanced crop rotation.



## TR-640

**Agency:**

Iowa State University

**Principal Investigator:**

Tom Cackler

**Research Period:**

November 22, 2011 –  
November 30, 2013

**Research Board Funding:**

\$150,000

**Funding Source:**

100 % State -  
40 % Primary funds,  
50 % Secondary  
funds and  
10 % Street funds

## Optimizing Pavement Base, Subbase, and Subgrade Layers for Cost and Performance on Local Roads

**Objective:** The objectives of this study include the following:

1. Determine the level of increased performance on local roads when PCC is placed on granular subbase or treated subgrade and quantify the performance and cost effectiveness.
2. Develop a user guide for various traffic, soils and pavement factors for optimized performance and financial benefits.

**Progress:** The research team is working on design calculations to determine the in-situ coefficient of drainage and reliability percentage based on field conditions of the test sites. These variables will be utilized with the 1993 AASHTO pavement design formula to evaluate the benefit of pavement support materials. Fifteen sites were tested across the State with various subbase and subgrade conditions. The results are anticipated to be complete by the end of October 2012. Each of the pavements will be compared using the pavement distress and the field test results for the underlying subbase or subgrade condition.

**Reports:** None

**Implementation:** The guide will be published and circulated statewide by incorporating the findings into Chapter 6 of the SUDAS Design Manual. The guide will also be published on the IHRB and CP Tech Center Website. Upon completion of the study, SUDAS, County Engineers and Municipal Engineers would be responsible for applying the research results. Specific standards or practices that may be affected include SUDAS and the Iowa DOT design manual and specifications.



## TR-641

**Agency:**

Iowa State University

**Principal Investigator:**

Chris Williams

**Research Period:**

November 22, 2011 –  
October 31, 2013

**Research Board Funding:**

\$99,966

**Funding Source:**

100 % State -  
40 % Primary funds,  
50 % Secondary  
funds and  
10 % Street funds

## Reflective Crack Mitigation Guide for Flexible Pavements

**Objective:** The objectives of the study are:

1. Develop guidelines for project selection including but not limited to design considerations such as existing pavement type, thickness, and distress, patching needs, traffic, and minimum subgrade support required.
2. Review preferred practice of rubblization and crack & seat techniques and the selection of proper fracture size and how it relates to performance. Develop quantitative quality acceptance criteria for these projects and recommendations for the use of leveling course material.
3. Develop a mechanistic, performance-based life cycle cost analysis with the MEPDG to further aid in project selection using these crack mitigation techniques based on previously completed studies on reflective crack mitigation techniques.

**Progress:** The literature review was completed and field locations for the various types of methods for mitigating reflective cracking have been identified. For the rock interlayer approach, local agency sites have been identified with challenges in accrued field performance being an issue. The research team has contacted the Special Investigations group and others at the Iowa DOT for data mining the various pavement sections using alternative crack mitigation techniques.

All of the pavement selections for the various types of reflective crack mitigation techniques have been identified. The pavement structure for some of the pavement sections has been determined. Preliminary pavement design analysis for some sections has been done.

**Reports:** None

**Implementation:** The benefits of this research will be improved pavement performance for Iowa jurisdictional agencies and the Iowa DOT. The project will provide guidelines for assisting engineers in selecting cost effective strategies for mitigating reflective cracking. Further construction guidelines for the strategies for mitigating reflective cracking will also be provided- currently there are no guidelines for crack & seat and rubblization in Iowa.

## TR-642

**Agency:**

The University of Iowa

**Principal Investigator:**

Witold F. Krajewski

**Research Period:**

February 1, 2012 – January 31, 2014

**Research Board Funding:**

\$172,721

**Funding Source:**

100 % State -  
40 % Primary funds,  
50 % Secondary  
funds and  
10 % Street funds

## Pilot Project for a Hybrid Road-Flooding Forecasting System on Squaw Creek

**Objective:** This project is a 2-year plan for the design, implementation and evaluation of a hybrid flood forecasting system that combines real-time stream level observations with a state-of-the-art distributed hydrologic models called CUENCAS. The system will, over time, provide accurate predictions of flooding potential for each and every road/stream intersection in a river basin. The observation component of the system is accomplished with a stream-level sensing device, which uses ultrasound technology to measure the distance from the bridge deck to the stream water surface.

The device is designed for installation under the deck of a bridge. The hydrologic model provides a faithful representation of the waterways in a river basin and does not rely on calibrated parameters. However, it depends on the accurate description of travel times along the channels of the river networks.

**Progress:** The project investigators have constructed all 25 sensors but deployed only 17 of them to date. The remaining 8 require building customized mounting brackets and will be deployed by the end of the year. The seventeen deployed sensors work well and provide data in near real time (every 15 minutes) to the database located at the Iowa Flood Center. Project investigators have developed a rainfall-runoff model for the Squaw Creek basin but are unable to test it due to the continuing drought. Overall the project is progressing on schedule and without major technical difficulties.

**Reports:** None

**Implementation:** A distributed flood-forecasting mathematical model capable of highly accurate predictions (i.e. with errors on the order of 1%) could replace the need for a network of observations by making predictions of flooding in all the intersections of roads and streams in a river network. However, the level of accuracy of current hydrologic models is much lower (~ 50% error) precluding their use as a sole forecasting tool of road conditions. In addition, the architecture of standard hydrologic models precludes the ability of forecasting flood levels on small tributaries. As an example, the National Weather Service provides routine stream level forecasts for about 100 locations in the state of Iowa. These forecasting locations usually correspond to large cities or highly populated regions, but provide no information on small creeks or the multiple intersections of roads and streams.

## TR-643

**Agency:**

Iowa State University

**Principal Investigator:**

Halil Ceylan,

**Research Period:**

January 15, 2012 –  
July 31, 2013

**Research Board Funding:**

\$119,975

**Funding Source:**

100 % State -  
40 % Primary funds,  
50 % Secondary  
funds and  
10 % Street funds

## Evaluating Roadway Subsurface Drainage Practices

**Objective:** The objectives of this project are as follows:

- Conduct a comprehensive performance review of pavement subdrains in Iowa.
- Include the condition of the drains and a determination of whether they are functioning as designed
- Evaluate a corresponding pavement to determine if pavement deterioration is occurring at the drain locations.
- Determine the cause of the problem if there are drains that are not functioning properly.
- Make recommendations for improvements to the pavement drainage system, when appropriate.

**Progress:** The research team contacted and consulted Iowa District Maintenance Engineers on site selection in pursuit of field investigation for Task 3 (Forensic Testing and Evaluation). The input from district maintenance engineers have been incorporated into a list of candidate sites and a forensic test plan. About 80 sites have been identified from this task.

The subsurface drainage forensic testing and evaluation program was also initiated. Five sites in I-35 and US-30 have been visited and investigated so far. The preliminary findings from these sites are: (1) Tufa was observed but it did not always make drainage outlet non-functional (caused more than 50% blockage) and (2) little pavement cracking was observed on surface nearby drainage outlet but several mid-panel cracks were observed on pavement surface nearby culverts.

**Reports:** None

**Implementation:** Based on the outcome of this study, the research findings will be directly used by Iowa city, county, and DOT engineers to assess the performance of their pavement subdrains and improve their drainage practices.

## TR-644

**Agency:**

Iowa State University

**Principal****Investigator:**

Brent Phares

**Research Period:**

August 27, 2012 –  
December 31, 2015

**Research Board  
Funding:**

\$90,000

**Funding Source:**

100 % State -  
40 % Primary funds,  
50 % Secondary  
funds and  
10 % Street funds

This project is jointly  
funded with the  
Minnesota Local  
Roads Research  
Board.

## Development of Cost-Effective Timber Bridge Repair Techniques

**Objective:** Currently no sources of guidance for the repair of timber bridges exist. At the same time county engineers have recognized several types of timber bridges that are in need of repair and maintenance; this represents a major concern. This project is to identify the state-of-the-practice of timber bridge repair through national and international search and to marry those repair techniques with the needs of county engineers. The efficacy of those techniques will then be evaluated from both engineering and fiscal perspectives. Through a multi-pronged approach, the most viable techniques will be communicated to engineers through a coordinated outreach effort.

**Progress:** A contract for services is currently being executed. No work has begun on the project.

**Reports:** None

**Implementation:** The principal benefit of the work proposed here will be that local system engineers will have formal guidance for repairing timber bridge components. Currently county and city engineers have little to no State or national sources to which they can turn for guidance on the repair of timber bridges. This represents a significant problem as they strive to ensure the safety of the travelling public. The benefit of having such a resource will be measured by improving the overall condition of the transportation system and reducing system failures through implementation by local officials.

## TR-645

**Agency:**

University of  
Minnesota - Duluth

**Principal  
Investigator:**

Brian K. Brashaw

**Research Period:**

August 13, 2012 –  
December 31, 2014

**Research Board  
Funding:**

\$60,000

**Funding Source:**

100 % State -  
40 % Primary funds,  
50 % Secondary  
funds and  
10 % Street funds

This project is jointly  
funded with the  
Minnesota Local  
Roads Research  
Board.

## Development and Integration of Advanced Timber Bridge Inspection Techniques for NBIS

**Objective:** Inspections for timber bridges have been mostly limited to visual inspection, hammer sounding and probing. These techniques have proven appropriate for advanced decay detection, but are inadequate for early stage or internal deterioration. It is critical that efforts be conducted to develop and implement advanced timber inspection techniques into routine bridge inspections in accordance with National Bridge Inspection Standards (NBIS) requirements.

This project will result in improved assessment information that can be used to improve the safety and reliability of bridges. An experienced research team will identify and help implement an inspection protocol for timber bridges (with an emphasis on timber substructure) that can accurately assess structural condition and support the load rating process. Key milestones include the development of standard inspection protocols, integration of the results into bridge data management software, development of a customized inspection manual, outreach training for districts, recommendation of equipment purchases, and completion of an economic assessment on the use of advanced inspection techniques.

**Progress:** A contract for services is currently being executed. No work has begun on the project.

**Reports:** None

**Implementation:** This project will provide clear implementation strategies that can be used to accurately identify deteriorated structural timber members and provide key information that can be used to adjust load ratings, develop repair strategies and improve maintenance. One outcome from the project will be a recommendation for the purchase of timber inspection equipment for sharing within the State. Training and outreach will be conducted for inspectors and engineers for each District. By providing training and access to advanced timber inspection equipment, the project will improve the safety and reliability of timber bridges.

## TR-646

**Agency:**  
HDR Engineering

**Principal Investigator:**  
Phil Roszbach

**Research Period:**  
May 10, 2012 –  
June 30, 2013

**Research Board Funding:**  
\$289,494

**Funding Source:**  
100 % State -  
40 % Primary funds,  
50 % Secondary  
funds and  
10 % Street funds

## Development of Bridge Inspection, Load Rating & Maintenance Manuals

**Objective:** Under a project funded by the Iowa Highway Research Board, HDR will provide services to the Iowa Department of Transportation to develop Bridge Inspection, Load Rating and Maintenance manuals with the intent of capturing existing Office of Bridges and Structures (OBS) policies and procedures, and summarizing current and past knowledge of DOT staff in these areas. The manuals would utilize a .pdf format in order to have sections or pages that may be linked to Iowa DOT's Structure Inventory and Inspection Management System (SliMS) software.

**Progress:** The first phase of the effort included development of topic outlines for separate Inspection, Load Rating and Maintenance Manuals. Phase I was completed in August 2012. This second phase of the development of the manuals incorporates the actual writing, development of figures and incorporation of figures and photographs into the individual manuals. The second phase, begun in September 2012, will also assign links to the SliMS program, although actual programming of the links would be performed by InpectTech, the developers of the SliMS software.

**Reports:** None

**Implementation:** The manuals will provide the required technical information and guidance to allow DOT Bridge staff and District maintenance personnel to consistently inspect, evaluate and maintain on-system bridges. A secondary benefit will be to provide a framework for policy guidance to local municipal and county bridge owners and employees as well as to independent bridge consulting firms working for the State or local entities.

## TR-647

**Agency:**

Iowa State University

**Principal****Investigator:**

Brent Phares

**Research Period:**

July 1, 2012 –

December 31, 2013

**Research Board  
Funding:**

\$143,391

**Funding Source:**

100 % State -

40 % Primary funds,

50 % Secondary  
funds and

10 % Street funds

## Methods for Removing Concrete Decks from Bridge Girders

**Objective:** The objective of this work is to determine the most, and/or develop new, cost-effective and efficient deck removal techniques for steel and prestressed concrete superstructure bridges. Further, the work proposed herein will include guidance on assessing and repairing steel girders that are damaged during removal of a deck. The following criteria will be considered as part of the evaluation: Impact on the future performance of the superstructure, Cost, Time, Safety, and Noise

**Progress:** This project has just begun. The investigator has initiated a state DOT questionnaire to begin collecting information that will be helpful in subsequent phases. Additionally, they have been organizing the meetings with contractors.

**Reports:** None

**Implementation:** At the conclusion of this project, a suite of tools will exist that will allow bridge owners to make informed decisions regarding the removal of concrete decks from bridges. The outcomes of this work will be immediately implementable as standards of practice will be developed.



## TR-648

**Agency:**

Iowa State University

**Principal Investigator:**

Peter Taylor

**Research Period:**

July 1, 2012 –  
June 30, 2016

**Research Board Funding:**

\$83,049

**Funding Source:**

100 % State -  
40 % Primary funds,  
50 % Secondary  
funds and  
10 % Street funds

## Evaluation and Testing of a Light-Weight Fine Aggregate (LWA) Concrete Bridge Deck

**Objective:** The objective of this project is to perform laboratory and field testing and evaluation of a concrete bridge deck constructed with LWA concrete. The CP Tech Center will conduct material tests on the LWA and concrete mixtures used in the bridge deck, both in the lab and during construction. In addition, the Bridge Engineering Center (BEC) will conduct live load field tests to evaluate the performance and condition of the LWA deck and the control deck both at the time of placement and approximately 1 year after construction. Evaluation of performance will be made through comparisons with design assumptions, previous research, and the performance of the LWA deck compared to the control.

**Progress:** Samples of lightweight materials have been received and a laboratory test plan is being finalized. Communications have been started with the County Engineer to coordinate field activities.

**Reports:** None

**Implementation:** The benefits of this research include collected field data and information regarding the structural performance of LWA in concrete bridge decks compared to a similar bridge deck constructed of normal weight concrete. By providing internal moisture to the concrete, the LWA facilitates internal curing of the concrete, in turn, reducing the short and long term shrinkage cracking that often results during concrete curing. With no reduction in strength, concrete with reduced shrinkage cracking has a potential advantage over typical concrete mixtures in our Midwest climates and the subsequent use of deicing salts in the winter months. In addition, there is the potential for improved durability, as well as economic benefits as well.

## HR-1027

**Agency:**

Iowa Department of  
Transportation

**Principal  
Investigator:**

Vanessa A. Goetz

**Research Period:**

March 1980 –  
on-going

**Research Board  
Funding:**

\$85,000/year (covers  
salary and state share  
of costs for FICA,  
IPERS, health  
insurance, vehicle  
costs and expenses)

**Funding Source:**

100% State -  
100% Secondary  
funds

## Secondary Road Research Coordinator

**Objective:** This is a full-time position at the Iowa DOT. The coordinator's jobs are to act as a research liaison with all of the county engineers and solicit new, innovative and progressive ideas. He or she also actively promotes research for solutions to problems and ideas that will improve quality and reduce costs on the secondary road system.

**Progress:** Vanessa Goetz continues communications with county engineers to discuss problems encountered by secondary road departments and to discuss current research projects throughout the year.

At any one time as much as 50 percent of IHRB projects involve the secondary road system, including secondary projects with consultants. The coordinator assists these counties with special testing, evaluation and writing of reports necessary to the research and keeps county engineers updated on the latest important research results.

**Reports:** None

**Implementation:** There are many problems that are unique to the secondary road system in Iowa. These problems are often common to several counties. Coordination between counties is necessary for understanding the problems and formulating solutions. Proper documentation and dissemination of research results allows for timely technology transfer to and between the counties.